dure, and the use of protamine. The results were analyzed and used for comparison between the use of these medications for CEA vs CAS.

Results: Of 2434 recipients who were sent a questionnaire, 653 (27%) participated in the survey. Of these 653 participants, 649 (99%) stated that they perform CEA and 598 (93%) perform CAS. Of the 649 vascular surgeons that perform CEA, 85% use aspirin alone preoperatively. Plavix was used by 4%, and both were used by 9.7%. Ninety-nine percent use heparin during the procedure, and 48% use protamine to reverse the heparin dose. Of the 598 vascular surgeons that perform CAS, only 41% use a combination of aspirin and Plavix before the procedure. Aspirin alone was used by 26.8% and Plavix alone by 45.3%. Ninety-three percent use heparin during the procedure (6.2% used bivalirudin), and only 16% reversed the heparin dose with protamine. Platelet inhibition before either intervention is almost never assessed (3.5% with CEA and 3.9% with CAS).

Conclusions: These results suggest that there is no difference between the numbers of vascular surgeons performing carotid endarterectomy compared with carotid artery stent placement. Conversely, there is a substantial difference in the selection of antiplatelet medications before the two procedures. In addition, there is a large difference in the administration of protamine after CEA compared with CAS. This survey suggests that there is no standard practice on the use of preprocedural medications or the use of protamine sulfate for heparin reversal during carotid procedures.

Carotid Surgery Is the Gold Standard for High-Risk (HRP) Carotid Artery Intervention: Five-Year Cost-Effectiveness and Quality Stroke-Free Survival Comparison Between Carotid Endarterectomy (CEA), Carotid Angioplasty, and Stenting Technique (CAST), and Optimal Medical Therapy (OMT)

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Background: Our aim was to conciliate carotid angioplasty and stenting technique (CAST) with CEA and optimal medical therapy (OMT) in high-risk patients. Primary end points were stroke, myocardial infarction, or death. Secondary end points were patency rate, cost-effectiveness, length of hospital stay, reintervention rate, quality of life, Q-TwiST (Quality-Adjusted Time Without Symptoms of Disease or Toxicity of Treatment), and cost per quality-adjusted life-year (QALY).

Methods: Between October 2001 and October 2008, 847 patients were evaluated with carotid stenosis >60%. Predicted probability of receiving CEA, CAST, and OMT was tabulated using multiple logistic regressions to control for comorbidity and anatomic high-risk factors. Propensity scoring adjusted for baseline characteristics and selection bias by matching covariables, creating a pseudorandomized control design for 306 CEA, 39 CAST, and 275 OMT, of which computer randomization generated 55 CEA, 34 CAS, and 67 OMT. Nineteen (6.3%) had bilateral interventions. Comorbidity Severity Scores were similar between groups ($P > .05$)

Results: All interventions were within a mean of 18 days from initial presentation. Mean age was similar between CEA (68.6 years) and CAST (70.6 years, $P > .05$) but OMT patients were significantly older (75.4 years) than CEA ($P < .01$) or CAST patients ($P < .05$). Duplex ultrasound was the sole preoperative imaging modality to quantify plaque-type morphology and degree of stenosis. After carotid intervention, overall 30-day stroke free survival rate was 99.1% (95% CI, 99.6%-99.9%). The 5-year stroke-free rate was 99.1% (95% CI, 99.6%-99.9%), stroke-free survival was 90.6% (95% CI, 85.9%-93.9%), and primary patency was 94.6% (95% CI, 90.5%-97.0%). The 5-year stroke free survival significantly improved with CEA (90.6%) compared with OMT (44.3%, $H = .22$; 95% CI, .08-.61; $P < .0001$). Cox proportional hazards ratio showed age >80 years ($P < .001$), female gender ($P < .04$), and echolucent plaque material ($P < .01$) were associated with reduced stroke free survival. Q-TwiST, and cost per QALY were in favor of CEA vs CAST ($P > .05$) and significantly improved with CEA vs OMT ($P < .0001$) and CAST ($P < .001$).

Conclusions: OMT does not prevent future stroke in patients with severe carotid artery disease. Indications for CAST are limited, and strict selection criteria should apply. Contemporary trends verify that stenting techniques and cerebral protection devices prerequisite device maturity before it befalls routine clinical practice. CEA is the gold standard in suitable patients with recently symptomatic carotid artery stenosis, with superior stroke-free survival rates at 5 years when compared with CAST or OMT.

Characterization of Resident Surgeon Participation During Carotid Endarterectomy and Impact on Perioperative Outcomes

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Objectives: The impact of resident care on vascular patient outcomes has not been well characterized. We analyzed resident surgeon participation during carotid endarterectomy (CEA), procedural characteristics, and associations with perioperative outcomes using the 2005-2008 American College of Surgeons National Surgical Quality Improvement Program (NSQIP) data file.

Methods: CEAs were identified using primary CPT codes. Comparisons based on resident participation were performed using χ^2 or Fisher exact test for categoric variables and *t* tests or nonparametric methods for continuous variables. Associations with complications (major: stroke, death, or myocardial infarction; minor: reoperation, reintubation, bleeding, or nerve injury) were assessed using logistic regression.

Results: Residents were scrubbed for 9937 of 17,542 CEAs analyzed (56.7%). Resident level was categorized as junior (postgraduate year [PGY] 1-2) in 20.9%, senior (PGY 3-5) in 52.9%, and fellow (PGY ≥6) in 26.2% of CEAs. Preoperative and procedural data based on resident participation status are reported the Table. Patients undergoing CEA who had a resident scrubbed had a longer mean anesthesia time (197 vs 159 minutes; $P < .0001$) but shorter hospital stays (39.5% vs 43.8% of patients hospitalized ≥1 day; $P < .0001$). Multivariable models did not reveal significant associations between resident participation and risk of major or minor complications.

Conclusions: Although resident participation during CEA was associated with longer anesthesia times, no effect on complications was observed and length of stay was shorter when residents were scrubbed. Resident contributions to postoperative care may favorably impact outcomes, and assessment of resident impact should not be limited to procedural factors.

Table. Preoperative and procedural data based on resident participation

Variable	*Resident*		P
	Absent	*Present*	
Age, years	71.2	70.5	<.0001
Weight, kg	80.4	80.6	NS
Female, %	41.8	40.4	NS
Diabetes	26.9	27.3	NS
Hypertension, %	85.2	85.3	NS
Coronary disease, %	37.6	36.4	NS
Current smoker, %	27.7	27.7	NS
Hematocrit, %	39.5	39.5	NS
WBC, 103/uL	7.7	7.7	NS
Serum creatinine, mg/dL	1.19	1.17	NS
Preoperative TIA, %	28.6	28.1	NS
Preoperative stroke, %	23.6	24.1	NS
General anesthesia, %	84.6	82.3	<.0001
ASA class ≥ III, %	91.1	89.0	<.0001
Emergent procedure, %	1.7	1.8	NS
Anesthesia time, min	158.9	196.6	<.0001
Intra-op transfusion, U	0.02	0.03	NS

The Malignant Course of Carotid Artery Occlusion: Risk Factor and Outcomes

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Objective: This study evaluated the long-term outcomes of patients with carotid artery occlusion and determined risk factors predictive of death, neurologic event, or contralateral carotid intervention.

Methods: Patients with carotid occlusion shown by duplex ultrasound imaging were retrospectively identified and followed-up between January 2002 and June 2010 (mean, 52 months; range, 1-93 months) at a tertiary care hospital. All had a minimum of three duplex examinations available for review. Analysis by χ^2 was used to determine risk factors for death, neurologic event, or contralateral intervention. Multivariate Cox proportional hazard analysis was conducted with *P* values < 0.1. Survival was estimated using the Kaplan-Meier method ($P < .05$ significant).

Results: Eighty patients with comorbidities commensurate for a tertiary care center were identified and available for analysis. At the initial encounter, 30 (38%) were symptomatic, with 23 (29%) having symptoms referable to the occluded carotid. During follow-up, 7 (9%) had a neurologic event, of which 6 (86%) were referable to the occluded side; 14 (18%) underwent a contralateral operation, and 19 (24%) died. Multivariate analysis revealed amaurosis fugax at initial presentation was a risk factor for contralateral operation ($P = .05$). Although numerous variables of multivessel disease were significant with χ^2 analysis, there was no significant risk factor associated with neurologic event upon multivariate analysis. Neck radiation ($P = .05$) and stenosis or occlusion of the external carotid

ipsilateral to the occlusion on follow-up ($P < .027$) were associated with increased risk of death. Kaplan-Meier analysis showed 7-year survival for patients with ECA disease at follow-up was significantly worse (16.2% ± 10.3% vs 79% ± 8.7%; $P < .00001$).

Conclusions: Patients with carotid occlusion frequently present with symptoms referable to the occlusion. Eighty-six percent of neurologic events originated from the occluded carotid, indicating that the process is not benign. Multivariate analysis revealed no factor, specifically, concurrent extracranial arterial disease, predictive of subsequent neurologic events. With significant risk of death in patients found to have ipsilateral ECA stenosis during follow-up, it seems reasonable to continue surveillance of the occluded carotid.

Table. Risk factors and outcome

Risk factor	*Contralateral operation*	*Neurologic event in follow-up*	*Death*
Prior neck irradiation	0.068	0.17	0.054[a]
At presentation			
Amaurosis fugax	0.078[a]	0.76	0.44
Ipsilateral ECA	0.17	0.19	0.005
Contralateral ECA	0.005	0.56	0.014
In follow-up			
Ipsilateral vert	0.3	0.019	0.29
Ipsilateral ECA	0.033	0.073	<0.000[b]
Contralateral ECA	0.62	0.46	0.061
ECA/vertebral stenosis or occlusion			
At presentation	0.053	0.098	0.007
Progression in follow-up	0.29	0.427	0.31

[a] $P = .05$;
[b] $P < .05$ in multivariate analysis.

Risk Modification Strategy of Acute Renal Failure in EVAR

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Objective: Acute renal failure (ARF) is a known complication after endovascular aortic aneurysm repair (EVAR), with a significant long-term consequence. However, there is no clear understanding of its etiology or appropriate preventative measures. Our primary objective was to identify independent risk factors of ARF after EVAR and delineate a risk modification strategy.

Methods: A retrospective analysis was performed on a prospectively maintained EVAR database. Demographics, imaging, operative record, hospital course, and follow-up information were evaluated. Univariate analysis was performed via *t* test or Fisher exact test. Survival curve was estimated by Kaplan-Meier method. Binary logistic regression model was used to identify the independent risk factors. Contrast dose cutoff was determined by receiver operator curve (ROC) analysis.

Results: A total of 588 patients (mean age, 76.39 years; follow-up, 26.3 months) were included. ARF developed in 13 of 386 patients (3.4%) with normal renal function and in 18 of 148 (12.2%) with chronic kidney disease (CKD) stage 3 ($P = <.001$). Fifty-four patients had chronic renal failure (stage 4 or 5). Patients who developed ARF had reduced long-term survival ($P = .012$ at 4 years) and increased prevalence or progression of CKD ($P < .001$) at follow-up. Independent risk factors of ARF were age, diabetes, smoking, baseline glomerular filtration rate, intraoperative contrast iodine amount (g), and duration between preoperative CT scan and the operation (scan duration). Preoperative medications, preoperative hydration, contrast type (iohexanol vs iodixanol), and operation-relevant anatomic factors of suprarenal fixation, maximal aneurysm size, proximal neck length, and neck diameter did not have a significant impact on development of ARF. ROC analysis indicated the optimal cutoff for contrast iodine dosage was 446 g (139 mL of iodixanol) for all patients (C-statistic, 0.73) and 373 g (116 mL) for patients with preoperative CKD stage 3 (C-statistic, 0.67). There was a significant reduction of ARF by increasing the scan duration to at least 7 days ($P = .004$), and this beneficial reduction was maintained at 7, 14, and 30 days, and beyond. No additional benefit was seen with each added time period after 7 days.

Conclusion: Post-EVAR ARF leads to CKD, faster renal function decline, and higher long-term mortality. Contrast iodine dosage and scan duration are independent risk factors that can be controlled by the surgeon. Using less than the above threshold amount of contrast and increasing the scan duration to at least 7 days will lead to significant reduction in ARF.

Outcomes of Mesenteric Reinterventions for In-Stent Restenosis in Patients Treated for Atherosclerotic Mesenteric Artery Disease

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Objective: Mesenteric artery stents (MAS) for chronic mesenteric ischemia (CMI) have been plagued by high restenosis and reinterventions rates. This study reviewed the outcomes of patients treated for mesenteric artery in-stent restenosis (MAISR) with open surgical (OR) or redo endovascular mesenteric revascularization (ER).

Methods: The clinical data of 157 patients (190 MAS) treated for CMI were entered into a prospective database (1998-2010). Fifty-six patients (37%) developed MAISRs, defined by duplex ultrasound peak systolic velocity >350 cm/s or angiographic stenosis >60%. We reviewed the clinical data and outcomes of patients undergoing reinterventions for MAISR. End points were procedure-related mortality and morbidity, and late patient survival, symptom recurrence, reintervention, and patency rates.

Results: There were 30 patients (19%) treated for MAISR, including 25 women and 5 men, with a mean age of 69 ± 14 years. Twenty-four patients presented with recurrent symptoms (27 chronic and 3 acute), and 6 had asymptomatic preocclusive lesions. Twenty-six patients (87%) had endovascular reintervention, including stent placement in 19 (15 uncovered and 4 covered) or percutaneous transluminal angioplasty (PTA) in 7. Four patients (13%) underwent OR, including one with acute ischemia. There was one death (3%) in a patient with acute ischemia treated with redo stenting. Seven patients (27%), all treated by ER, developed complications, including access site problems in four, and distal embolization with bowel ischemia, congestive heart failure or SMA reocclusion in one each. Symptom improvement was noted in 23 of the 24 symptomatic patients (96%). After a mean follow up of 29 ± 12 months, 11 patients developed a second restenosis, and 7 required treatment for recurrent symptoms. Rates of symptom recurrence, restenosis, and reinterventions were 0/4, 0/4, and 0/4 for covered stents, 2/7, 3/7, and 2/7 for PTA, 5/14, 8/14, and 5/14 for uncovered stents, and 1/4, 4/4, and 0/4 for OR. For all patients, freedom from recurrent symptoms, restenosis and reinterventions were 70% ± 10%, 50% ± 11% and 60% ± 11% at 2 years. For patients treated with ER, secondary patency rates were 73 ± 11 at the same interval.

Conclusion: Nearly 40% of patients developed mesenteric in-stent restenosis, of which half required reintervention because of symptom recurrence or a preocclusive lesion. Mesenteric reinterventions were associated with low mortality (3%), a high complication rate (27%), and excellent symptom improvement (96%).

Superior Patency of Covered Stents Over Bare Metal Stents in Patients with Chronic Mesenteric Ischemia

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Objective: Endovascular management of chronic mesenteric ischemia, usually with stent placement, has become an accepted management strategy. Unfortunately, this therapy is plagued by poor primary patency and high rates of restenosis, usually with the return of symptoms. Our hypothesis is that treatment of chronic mesenteric ischemia with covered stents is a better treatment option than bare metal stents.

Methods: A retrospective review was done on 108 consecutive patients successfully treated for chronic mesenteric ischemia with endovascular techniques between October 2005 and July 2010. There were only five known treatment failures, all of whom required open revascularization. There were no acute endovascular failures needing emergent operation. Eleven patients treated with balloon angioplasty alone were excluded, leaving 122 stented vessels (67 superior mesenteric artery [SMA], 52 celiac, 3 inferior mesenteric artery). Patency was established at defined follow-up intervals with duplex ultrasound imaging and arteriography if available. Life-table analysis and Wilcoxon statistic were used.

Results: There were 99 bare metal stents and 23 covered stents, with 14 covered stents used as primary therapy and 9 as secondary therapy within failing bare metal stents. Mean age of the patients was 63 years, and 71% were women. Abdominal pain was present in 86%, nausea and vomiting in 31%, and weight loss in 56%. Seven patients eventually required open mesenteric revascularization and nine died, but only two of mesenteric ischemia. Secondary patency for the entire group of stented vessels was 75% at 18 months. Primary patency for the bare metal stents at 18 months was only 34%, whereas the covered stents had 86% primary patency at 18 months ($P = .02$). Durable symptom relief and maintenance of weight were obtained in 91% of the patients with patent stents.

Conclusion: These preliminary data suggest superior primary patency of covered mesenteric vessel stents compared with bare metal stents. Covered stents may be appropriate as primary therapy in patients with chronic mesenteric ischemia, and are certainly an option for use with failed or failing bare metal stents. Further study is indicated.